Growing the TRANSPLANT ONION CROP

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GROWING LARGE ONIONS from transplants has been practiced by many growers in the South and Southwest since the beginning of the industry. Transplant crops are grown on one-third to one-half of the total acreage of onions in the United States. Growers may raise their own transplants or seedlings; or they may buy them from those who produce them for shipment.

By growing onions in a nursery a large number can be raised in a small space. Home gardeners in most parts of the United States find the use of transplants the most satisfactory method of growing the mild varieties such as the Sweet Spanish and the Bermudas.

The time-consuming hand labor that onions require necessitates that the highest possible yields be obtained per acre. The transplant method described makes it possible to increase yields by special fertilization, cultivation, weeding, and control of diseases and insects with an economic use of land, labor, and material. To get dividends the grower should select varieties that bulb well at the temperatures and day lengths of the locality. Varieties that bolt readily should be avoided.

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GROWING THE TRANSPLANT ONION CROP

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STATUS OF ONION TRANSPLANTING

GROWING ONIONS BY THE TRANSPLANT METHOD consists in starting the plants in seedbeds and in setting them in the field when they are large enough. On one-third to one-half of the onion acreage in the United States this method is now used. Recently the total acreage in onions has been 100,000 to 135,000 a year.

In the South and Southwest the seed is usually sown in open beds in late summer or early fall. Then the seedlings are large enough for transplanting in the late fall or early winter. In the North, however, the seed is sown during February or March in coldframes, hotbeds, or greenhouses. As soon as the weather is warm enough the plants are set in the field. Some northern growers purchase southern-grown transplants.

Generally in the South the commercial growers and home gardeners use the transplant method. In the North, however, growers rarely use it, but home gardeners do to a considerable extent.

The transplanted onions are usually larger and more uniform than those of the same variety grown from seed. The transplants are not susceptible to smut, and because they ripen earlier they usually escape severe injury from thrips.

AREAS PRODUCING THE TRANSPLANT CROP

The States chiefly concerned in growing the commercial transplant onion crop are Texas, Louisiana, and California. In Texas it is grown primarily in the irrigated Laredo and Winter Garden districts in the southern part of the State. The Laredo district extends as a narrow strip along the Rio Grande in Webb and Zapata Counties;

the Winter Garden district includes Zavala, Maverick, Dimmit, La Salle, and Frio Counties, as well as contiguous ones. In north Texas transplanting without irrigation is practiced around Farmersville, Collin County. Most of the commercial crop of onions in Louisiana is grown in the southern part of the State in the Lafourche and Pointe Coupee-St. Landry districts. In California the early transplant crop is grown chiefly in the upper San Joaquin, Coachella, and Imperial Valleys, while most of the intermediate crop is grown in the Delta district (the lower Sacramento and San Joaquin Valleys) and to some extent along the coast south of San Francisco.

SOIL REQUIREMENTS

In Texas onions are grown on a number of soils but are particularly adapted to the sandy, silty, and certain clay loams. Many of the sandy loams in the irrigated districts of southwest Texas are fairly shallow and underlain by a rather impervious clay, making them ideal for the irrigation of a shallow-rooted crop like onions, as leaching of fertilizer materials is kept to a minimum. The heavier loams require less fertilizer for the production of a good onion crop, but because these soils dry out more slowly some difficulty may be experienced at harvesttime. Other conditions being equal, onions will usually mature earlier on the lighter soils than on the heavier and darker silt and clay loams. Onions growing on the lighter soils seem to have more pink root, probably because of higher soil temperatures.

In Louisiana the onions are usually planted on the lighter alluvial soils along the bayou or river front.

In California the early crop is grown on a variety of mineral soils, but a portion of the intermediate crop is grown on the peat and muck soils of the Delta district.

The onion thrives well on slightly acid soil (pH 6 to 6.5), but it grows poorly on very acid soil. To very acid soil a ton of hydrated lime should be added per acre each year until the acidity of the topsoil is sufficiently reduced. Most of the irrigated soils are alkaline in reaction and do not require liming.

Onion soils should be retentive of moisture, but they should be well drained. Waterlogged soils should be avoided.

FERTILIZERS

Whenever possible the soil should be improved by the addition of organic matter, either through the use of barnyard manure or by plowing under green manures. The latter practice is increasing in Texas and throughout the Southwest.

Manure is important in growing onions on mineral soils, especially those poor in humus. If the manure is not well rotted it should be applied to the crop preceding the onions. From 15 to 20 tons per acre is considered sufficient. On many soils manure should be supplemented with commercial fertilizers to produce the best results; where manure is not available, equally good results may be obtained with fertilizers alone. Muck or peat soils do not require additional humus; and nitrogen, phosphorus, and potash can be supplied more economically in chemical fertilizers.

The application of commercial fertilizers is usually profitable irrespective of the soil type, as the onion root system is comparatively

limited and the feeding zone rather restricted. Extensive tests by the Texas Agricultural Experiment Station on several soil types and in scattered localities in the Winter Garden and Laredo districts of southwest Texas indicate that fertilizer mixtures such as 6–12–0, 6–18–0, and 5–15–0 should be applied at rates ranging from 600 pounds per acre on the silt and clay loams to 1,000 pounds on the sandy loams. Higher grade fertilizers such as 16–20–0 and 11–48–0 are applied at proportionately lower rates. Some growers mix the 16–20–0 and 11–48–0 fertilizers in a 50–50 mixture to obtain a 13.5–34–0 ratio. With the exception of the 16–20–0 fertilizer, all those mentioned have 1–2–0, 1–3–0, or 1–4–0 ratios, or ratios approximating these. The 1–2–0 fertilizers are better adapted to the heavier soils and the 1–3–0 and 1–4–0 are better suited to the lighter soils. In other words, less phosphoric acid in proportion to nitrogen is needed on silt and clay loams than on sandy loams. Onions on sand and sandy loams usually show much more response to fertilizer applications than those on silt and clay loams.

Side dressings of 75 to 125 pounds of nitrate of soda per acre are commonly applied, especially in January or February. Tests indicate, however, that such side dressings are of questionable value except on certain very fine sandy loams adjacent to the Rio Grande or where the crop is showing a noticeable yellowing of foliage due to a lack of nitrogen. Side dressings, even of a balanced, fairly soluble fertilizer, do not equal in value the same material applied to the soil before the crop is set out. The most efficient method is to have equipment that will make the beds and place the fertilizer beneath the row all in one operation. This method is usually the cheapest and most satisfactory; the yield is usually heavier than where the same amount of fertilizer is applied broadcast.

In California, experimental data as a basis for specific fertilizer recommendations are meager. In the light of available information, however, it is recommended that for the peat land of the Delta district a fertilizer be applied that will supply 150 to 180 pounds of phosphoric acid and about 100 pounds of potash per acre. An application of 1,000 pounds per acre of 0–10–12 plus 300 to 400 pounds per acre of superphosphate should prove satisfactory. The amount of potash depends on whether a fertilizer containing potash has been applied to the soil in recent years. Onions on peat soils apparently make no response to the application of nitrogen. In some places, however, nitrogen applied as a side dressing, after the plants are growing, might prove beneficial.

For mineral soils the first choice is 300 pounds of sulfate of ammonia per acre applied in the center of the bed to a depth of 3 to 4 inches. If this is not available, 1,000 pounds per acre of a 6–10–4 or 6–9–6 fertilizer can be used; in addition a side dressing of 100 to 150 pounds per acre of nitrate of soda or sulfate of ammonia when the onions are small is recommended. For high yields of onions it is essential to get a good top growth before bulb formation begins.

In areas where phosphorus is deficient, as in the Cuyama Valley of California, 600 pounds per acre of a 10–20–0 or 400 pounds of a 16–20–0 fertilizer should be used in place of a straight nitrogen fertilizer.

In Louisiana 400 to 600 pounds of 4–12–4 fertilizer is applied per acre well mixed in the row 10 days to 2 weeks before transplanting.

As a rule, a side dressing of nitrate of soda at the rate of 50 pounds per acre is given when plants are about the size of a lead pencil. A second application at the same rate is given about 4 weeks after the first.

PREPARATION OF THE SOIL BEFORE PLANTING

Preparation of the soil when irrigation is necessary depends upon the system of irrigation to be followed and is about the same whether seedlings or the transplant crop is to be grown. Land should be thoroughly prepared by plowing, disking, and harrowing. If the soil is especially foul with weeds, it will often pay to irrigate the seedbed 2 or 3 weeks before planting time and then kill the crop of weeds which appear by disking or harrowing. The disking should be rather shallow to avoid bringing to the surface too much new seed-laden earth.

In many districts, especially on the upland mineral soils, raised beds similar to those used for growing lettuce and carrots under irrigation in California are used for the growing of both the transplants and the bulb crop. The soil should be in a well-pulverized condition so that the beds will be free from large lumps. For small plantings the beds are usually thrown up with a lister and then shaped with a sled, but for the larger ones usually both operations are performed at one time. The beds are made 36 to 42 inches from center to center and about 4 inches high.

In certain districts of the Southwest where the border system is followed, ridges 6 to 8 inches high and 150 to 300 feet long are made 5 to 12 feet apart. These are laid out on the contour of the land, as shown in figure 1, so that the entire area between the borders can be flooded uniformly.

On the peat lands of the Delta district of California the land is plowed, disked, harrowed, and floated. Small irrigation or "spud" ditches are run through the field at intervals of 80 to 100 feet. The soil from the ditches is leveled so that the land can be planted to the edge of the ditch.

GROWING ONE'S OWN TRANSPLANTS, OR SEEDLINGS

If an especially fertile soil can be chosen for the seedbed the use of commercial fertilizer will be unnecessary, but if a poor soil has to be used or if the seedlings grow weakly or have an unhealthy yellowish-green color, a fertilizer application is often desirable. In Texas 50 to 100 pounds per acre of an 11–48–0 or 100 to 200 pounds of a 5–15–0 can be used before the seed is sown. For side dressings nitrate of soda at 75 to 100 pounds per acre is usually satisfactory.

It is important that the seedbed be planted on soil free from pink root infestation. Even if the disease was not observed on the previous crop, it is best to avoid land on which onions have been grown at any time during the previous 4 or 5 years. If pink root occurs in the seedbed the disease will be carried to the field at transplanting time, and yields will be reduced.

In the production of transplants the chief object is to produce as many as are needed in as small a seedbed as is consistent with the production of healthy, vigorous, pencil-size plants. Over 112,000

FIGURE 1.—A contoured onion seedbed in Texas.

plants are required for an acre in which the plants are set 4 inches apart in 14-inch rows. For any spacing approximating this it is a common practice to sow 2 pounds of seed for every acre of the transplanted crop. Most growers expect to obtain enough plants from 1 acre of seedbed to set 10 acres. Seedbeds of 5 to 20 acres are not uncommon in south Texas.

In south Texas, seed of the Bermuda varieties is usually planted from September 15 to 25, whereas Early Grano (Babosa) and related varieties should be sown in early September. In the Collin County district of north Texas the few growers who raise their own plants usually sow the seed about October 15.

Tests reported by the Texas Agricultural Experiment Station indicate that 17 to 20 pounds of seed per acre of seedbed produces enough plants to set 10 acres with a maximum proportion of the desirable pencil-size plants. Grading plants at transplanting time may be impractical because of the time and expense involved; therefore it is important to adjust the rate of seeding so that a maximum number of medium-sized plants will be produced. With heavier rates of seeding, such as 30 to 35 pounds per acre, most of the plants are too small to make good transplants. Some growers use a spreader on the seeding machine to scatter the seed over either a 2- or 4-inch strip. In these wide rows seeding rates can of course be higher, but unless the land is practically free from weeds such rows require much more hand labor. Rows are usually 14 to 16 inches apart.

In Louisiana seed is usually drilled in the seedbed from October 1 to 15 in rows 4 to 6 inches apart. The seedbed may be covered with moss or other material kept damp until the seedlings are up.

In California the seed for the transplant crop is usually planted on raised beds in rows 2 to 8 or 10 inches apart. On the peat soils of the Delta district rows are spaced close together on wide beds, as many as eight rows being planted on one bed (see cover illustration). On sediment soils raised beds are generally used, either two or four rows

FIGURE 2.—Growing four rows of Stockton Yellow Globe onion seedlings on a bed for the intermediate crop in the lower San Joaquin Valley, Calif.

being planted on a bed (fig. 2). Occasionally seed is broadcast in open beds or hotbeds and then raked in. The date of planting depends upon the location within the State, the variety to be used, and the time it is desired to have the crop mature. Seeding is generally done between September 1 and October 1.

In the North the seed is usually sown in coldframes, greenhouses, or hotbeds 10 to 12 weeks before the plants are to be set in the field. Seed is usually sown thinly—10 or 12 to the inch—in rows about 4 inches apart and about one-half inch deep. Dusting the seed at time of sowing with some organic mercury compound helps to prevent pre-emergence damping-off and usually increases the number of seedlings. Because of their susceptibility to damping-off onion seedlings are much more difficult to grow indoors than out in the open; therefore care must be used in watering. Especially while the plants are small, watering should be avoided during cloudy weather; on bright days it should be done the first thing in the morning so that the soil surface will dry before night. After the first true leaf has appeared there is much less danger of loss from damping-off. The best seedlings are produced at cool temperatures. A night temperature of 50° F. and a day temperature of 60° to 65° are satisfactory, but a slightly higher temperature during the day will do no harm on clear days. Plants should be set in the field in early spring just as soon as the soil can be worked. If the seedlings are tender they should be hardened somewhat before they are planted in the open by watering less frequently and by exposing to night temperatures of 40° to 45° for a week or 10 days.

Southern-grown plants are now available for transplanting in most districts, and many home gardeners prefer to buy these rather than to grow their own supply.

GROWING AND HANDLING TRANSPLANTS FOR SALE AND SHIPMENT

Growing onion plants for shipment is a considerable industry in south Texas, Georgia, and some of the other Southern States. Growers often specialize in this type of business to the exclusion of growing dry bulbs; others conduct both enterprises. Some growers specialize in carlot or truck shipments; others confine their activities to mail-order and express shipments. Although the individual shipments may be small the total volume of business may be large. Growers catering to small individual orders often ship onion plants 8 months in the year and plant and have seedbeds 10 months. Shipments go to every State in the Union, as well as to Canada and Cuba. Peak shipments of onion plants come in late winter or early spring when the northern demand is greatest.

The chief problem of the onion-plant grower who caters to a year-round business is to estimate the demand for the different months and to have the right number of plants available at the proper time. He must know the approximate time needed to grow a transplant at the different seasons of the year. Seed planted toward the end of September in south Texas will produce good transplants in late November or early December, while seed planted toward the end of October may not be ready for pulling until late January or early February. Growers become adept in timing irrigations so as to speed up or slow down growth rate of the seedlings so they will be available at the right time for planting in the various districts.

As the plants are often in transit for a week or more, they must be handled so as to prevent decay. They are pulled and tied in bundles; the roots and tops are trimmed; the plants are packed upright in dry, well-aerated, flat crates for shipment.

TRANSPLANTING

In the South and Southwest the plants are usually ready to be set 8 to 10 weeks after seeding. Early Grano often grows somewhat faster than the Bermuda varieties and therefore reaches transplanting size somewhat sooner. In Texas transplanting usually occurs during November and December but may extend into early January. Early plantings of medium-sized plants usually produce heavier crops than late plantings, other conditions being equal.

Healthy vigorous seedlings about one-quarter to five-sixteenths inch in diameter at the neck and about 7 to 13 inches in height before pruning are best. The seedlings may be plowed out, but a common procedure is to irrigate the seedbed in advance so that they can be easily lifted without plowing. As a worker accumulates a handful of plants he removes a portion of the tops by a quick twist of the hand. If roots are long they are also trimmed by shears, whole bunches being clipped at one time (fig. 3). The pruned seedlings are about 5 to 6 inches long. Experiments conducted in Texas and California show that a considerable reduction in yield of bulbs occurs when both tops and roots are pruned. The only advantage is that pruning does facilitate transplanting.

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FIGURE 3.—Pulling and trimming Bermuda onion seedlings for transplanting, upper San Joaquin Valley, Calif.

The very small plants should be discarded, as both the Texas and California Agricultural Experiment Stations have shown that they are consistently less productive than medium-sized plants. Large plants produce higher total yields than either small or medium plants, but the marketable yields may be reduced by the presence of too large a proportion of splits, doubles, and bolters—all cull grades.

In Texas the seedlings are pulled, pruned, and placed in baskets or crates; then they are distributed ahead of the planter along three rows at a time, as shown in figure 4. All transplanting is done by hand. A short stick or dibble is used by most workers to make a hole and to press the soil around the plant. Experienced planters can scatter and set as much as one-third acre (37,000 plants) a day, but the average planter usually sets about one-fifth to one-fourth acre. Most of the planting is done by contract, the workers being paid by the number of acre rows (a row 210 feet long) set.

To facilitate irrigation on the uplands in Texas, low ridges are usually made 14 to 16 inches apart; the seedlings are planted one row to a ridge. The rows are marked by various means to facilitate uniform spacing. One method is to use a lightweight metal or wooden roller, as shown in figure 5, having slats 3½ to 4 inches apart, the distance apart the plants are to be set in the row. On the bottom lands, where the onions are grown in flat beds, or "melgas," between raised borders, very shallow furrows are made about a foot apart to mark the rows.

In California seedlings are transplanted in late November, December, and January. By the use of a small plow a furrow slice is thrown away from each side of the raised bed at the top. The seedlings are then laid against the side of the furrow, about 3 inches apart and at an angle of about 45°, with the tops toward the center of the bed. The roots are then covered, a lister or cultivator being used, and, if

FIGURE 4.—Transplanting onions in Texas. Three rows are set at a time. Seedlings are scattered ahead of the planter.

necessary, water is run between the beds to settle the soil about the roots. The plants are set so that the rows will be 8 to 10 inches apart on the bed (fig. 6) and a uniform distance apart to facilitate cultivation. In the Coachella Valley of California onions are grown in single rows on low ridges (fig. 7).

FIGURE 5.—This lightweight slatted roller leaves slight indentations 3½ to 4 inches apart to indicate every place in which a plant is to be set.

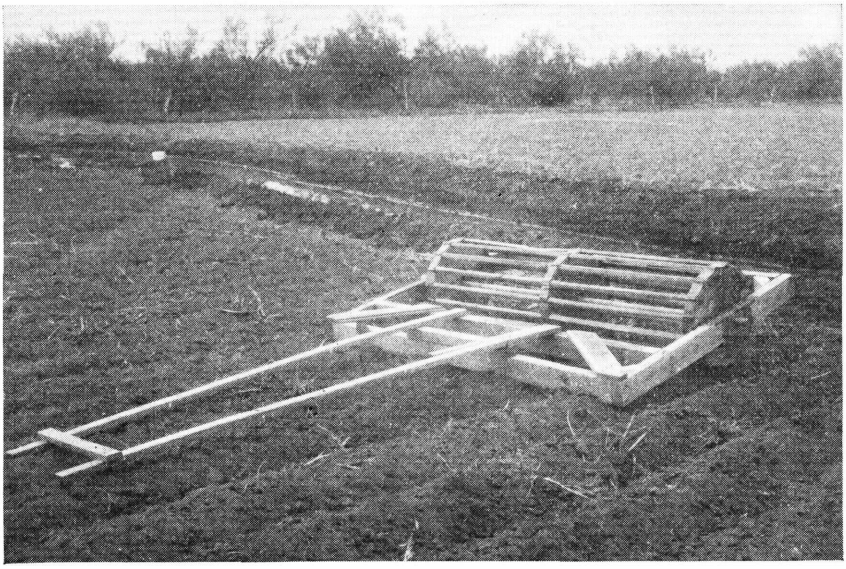

FIGURE 6.—Seedlings planted two rows on a bed, the system generally used in California for the transplant crop on mineral soils.

FIGURE 7.—Single rows on low ridges for growing onions in the Coachella Valley, Calif.

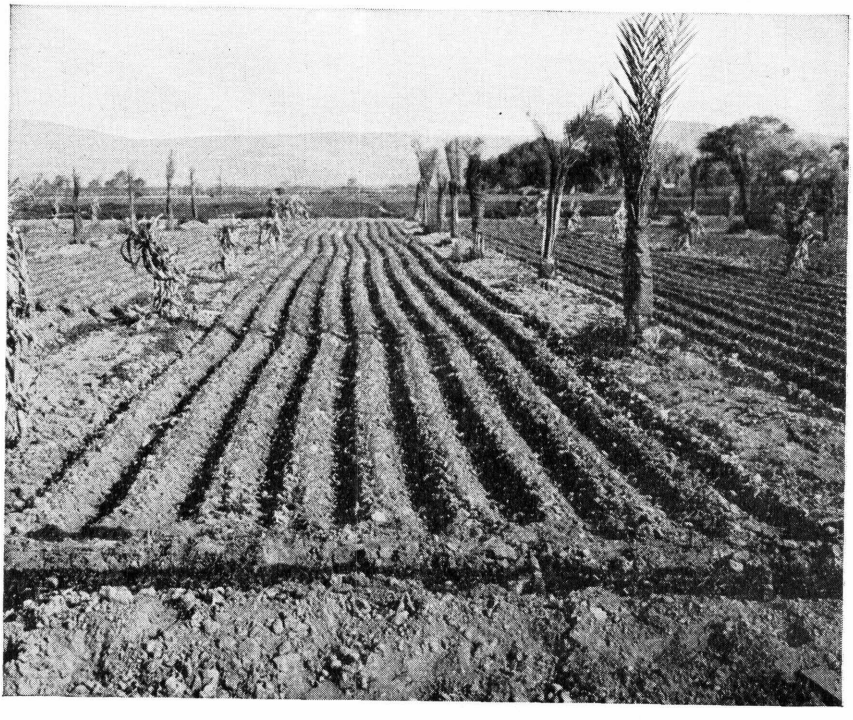

FIGURE 8.—Transplanted onions on peat land in the Delta district of California. The right plow of the cultivator covers the seedlings that have just been set. The left plow opens a new furrow. The seedlings in the box show the method of pruning generally used.

On the peat soils of the California Delta district the intermediate crop is set on the level. The rows are spaced about 10 inches apart, and the plants are set 3 inches apart in the row. A hand cultivator with two plows attached is used for planting (fig. 8). The right plow covers the plants that have just been set while the left one opens the furrow for the next row. Here, too, the seedlings are laid against the side of the furrow in a slanting position (fig. 9), but they gradually grow erect so there is no interference with cultivation. As the soil is usually moist during the transplanting season there is no need for irrigation.

When seedlings have reached the proper size, as a rule, they should be transplanted. Experiments with the intermediate crop in California show that early planting produces the heaviest yields and that, in general, as the transplanting date is delayed the yields are reduced. Generally, seedlings make very little growth above ground during the winter in central California, southern Nevada, and southern Utah and in a similar climate, but conditions are usually favorable for root development. Plants set early develop an extensive root system during the winter, so that they grow rapidly when the weather becomes warm in early spring. Onion plants start to bulb under conditions of temperature and length of day specific for the variety. Usually when environmental conditions become favorable for bulbing the larger plant will produce the larger bulb. Therefore, conditions that help

FIGURE 9.—Transplanted onion seedlings on peat land in the Delta district of California. Seedlings are laid in a slanting position on the side of the furrow and then covered. Within a few weeks the plants grow erect.

to produce a large plant also help to increase the size of the bulb and consequently the yield per acre.

In Louisiana, plants are set in the field sometime between December 20 and January 15. They are set about 4 inches apart in single rows on raised beds (fig. 10), which are about 3½ feet apart. Raised beds are used to provide drainage (fig. 11). Holes are made in the center of the ridge, into which the seedlings are dropped; then the soil is firmed about them.

IRRIGATION

The frequency and amount of irrigation required depend on so many variable factors, such as type of soil, amount of rainfall, condition of

FIGURE 10.—Transplanting Red Creole onions on raised beds, Pointe Coupee Parish, La. (Courtesy G. L. Tiebout.)

FIGURE 11.—Growing Red Creole onions on raised beds, to provide drainage, in southern Louisiana. (Courtesy G. L. Tiebout.)

crop, variety, and presence of thrips and diseases, that it is difficult to give definite rules to follow. Most of these factors vary from year to year and from farm to farm. If the soil is dry, onions should be irrigated as soon as possible after they have been set, as shown in figure 12. Many growers delay this operation too long; some do it intentionally, with the idea that such procedure is beneficial. Although onion seedlings will survive 12 days or more after being transplanted to a very dry soil, experiments have shown that such practice always results in lower yields. Roots continue to rise from the stem plate at the base of the onion plant during most of the time that the plants are growing. Because new roots are not formed unless the zone from which they rise is in moist earth the soil near the surface must be kept moist until the crop is nearly mature.

Most of the transplant crop of the Southwest and West is irrigated during part or all of the growing season. Onions must be kept growing steadily without any set-backs, as those which start new growth after being retarded may split or double and thus produce a smaller yield of U. S. No. 1 bulbs.

On the sandy loams of southwest Texas five to eight irrigations are usually all that are required between transplanting and harvest. More may be needed during seasons of heavy thrips infestation. From December to early March, irrigations can be 6 to 10 weeks apart, but beginning in March the frequency must usually be increased to once every 7 to 14 days. In southern Texas the especially strong winds prevalent at this time increase the water requirement.

Overirrigation, as well as lack of water, may cause reduction in yields. The foliage of onions receiving excessive irrigation acquires

FIGURE 12.—Irrigation water run between rows of onions just planted on dry soil.

a somewhat unhealthy yellowish-green color. This may be difficult to observe in a year of severe thrips infestation, but if the soil rarely gets dry it is good supporting evidence. Tests have shown that onions that receive just enough water will often yield as well as or better than those growing in soil which is continuously moist or wet on the surface. On the other hand, it is difficult to determine when a soil has been receiving too little irrigation, as the crop may appear healthy and vigorous.

On the peat lands of the California Delta district the surface of the onion land is usually below that of the water in the streams, and irrigation is carried on by siphoning and pumping the water from the rivers and network of waterways that surround the islands into large ditches that carry it to a system of laterals extending throughout the fields. The soil is open and porous, and when the water is raised in the ditches the water table is elevated throughout the entire soil area. The water is raised to within a few inches of the surface and is then pumped back into the river until the water level reaches the desired depth.

When the plants start to mature, irrigation should be discontinued and the soil allowed to dry out as much as possible; otherwise a second root growth which is difficult to stop may start and complicate the process of properly curing the onions.

CULTIVATION

Weed control is essential both in the seedbed and in the field, as onions must be kept free from weeds to produce maximum crops. All cultivations should be shallow, as the small feeder roots of the onion plant are near the surface. The crop is usually cultivated after a heavy rain and in irrigated sections after each irrigation. This controls weeds, prevents crusting of the soil, and facilitates the penetration

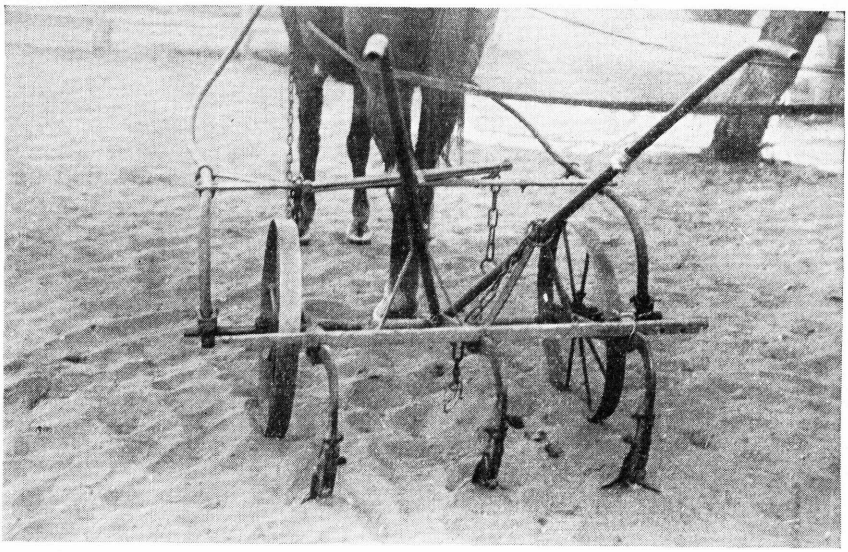

FIGURE 13.—A lightweight wheel implement used for cultivating onions in Texas.

of water at the next irrigation. Need of additional cultivations depends on the weed growth occurring between irrigations or rains. Cultivation should be discontinued if too much injury to the tops occurs.

Most Texas growers, especially those with more than a few acres of onions, use a lightweight wheel cultivator drawn by one mule, as shown in figure 13. Light tractors with attached cultivator equip-

FIGURE 14.—Weeding onions in Texas with small hand hoes.

ment are also commonly used. With either type several rows can be cultivated simultaneously.

As a rule, cultivation must be supplemented by hand weeding, both in the seedbed and in the field, as shown in figure 14; this essential operation is slow and tedious. In Texas, weeding is often done by contract at so much an acre, the price depending on the condition of the field. When an agreement has been reached the contractor gathers together a sufficient number of workers and does the job as quickly as possible.

BOLTING

In practically all the districts where the transplant crop is overwintered a high percentage of the plants may bolt; that is, they may produce seedstalks. As a rule, these plants are not marketable and therefore represent a loss. The amount of bolting is determined by the interaction of a number of different factors. Certain varieties tend to bolt much more readily than others. Sweet Spanish, White Sweet Spanish, Crystal Wax, Yellow Bermuda, White Creole, and Red Creole bolt rather readily; Red 21 (California Early Red), Stockton G36, Stockton Yellow Globe, Early Grano, San Joaquin, and Italian Red do not bolt so readily. The size of the overwintered plant also plays a very important part, as large seedlings bolt much more readily than small ones.

Aside from the variety and the size of the overwintered plant, the temperature is also important in determining the amount of bolting. The highest percentage of bolting occurs after a warm late fall and a cold late spring. A warm fall favors the development of a large plant for overwintering, and the combination of a large plant and a cool spring provides ideal conditions for bolting. Conversely, the fewest bolters occur after a cool fall and a warm spring. The effect of a difference of a few degrees of temperature on bolting is often evident in commercial fields. In districts where two rows of transplants are grown on raised beds running east and west, the north row on the bed frequently has more bolters than the south row. The north side of the bed is cooler because it does not get the direct rays of the sun and in addition is shaded by the south row. Also, more bolting occurs on heavier than on lighter soils, and low spots in the field that remain moist usually produce more bolters than well-drained areas.

HARVESTING AND CURING

The market price, condition of the crop, the weather, and the inclination of the grower all help to determine the actual date when harvesting is to begin. In general, growers start to harvest when 30 to 50 percent of the tops have fallen over. In most districts the tendency is to pull the crop when the bulbs have reached about their maximum size but while the tops are still green. Most commercial growers do not wait for the crop to mature fully. Studies in Texas and California, however, show that yields continue to increase until most of the tops have fallen over or at least have softened at the neck. Bulbs harvested when somewhat immature retain their outer scales longer and keep better during the short time that they may be held in storage.

If necessary the onions can be plowed out to facilitate harvesting. When four, six, or more rows are marked at a time in planting they

FIGURE 15.—Onions being cured in crates stacked in the field. Onion tops are placed on the upper crate to prevent sunscald.

can be plowed simultaneously at harvest by adjusting the same equipment. To cut the roots of onions grown on raised beds, some growers use a subsurface knife fastened horizontally between two boards and pulled by a team. Roots are cut several inches below the bulb. If the onions are somewhat immature they can be left standing in the row and allowed to ripen for a week or two. This system works particularly well with the Early Grano variety, which because of its heavy foliage usually ripens more slowly than the Bermudas. The last irrigation, however, often leaves the soil sufficiently soft to enable the onions to be pulled without being plowed.

As the onions are pulled they may be thrown into windrows and allowed to cure, or the tops and roots may be clipped off immedi-

FIGURE 16.—Early Grano onions being cured in baskets in the field, Batesville, Tex. (Courtesy W. B. Cook.)

ately and the bulbs placed in crates, baskets, or other containers (figs. 15 and 16). The length of curing depends on the maturity of the crop and on the atmospheric conditions. If the onions are fairly mature, the humidity low, and the air movement good, it is not unusual to pull, clip, and ship the same day. If the crop is windrowed in hot sunny weather the bulbs should be protected by overlapping tops to prevent sunscald. The tops are clipped to leave a short neck; cutting too close to the bulb is undesirable (fig. 17), as a large open wound does not dry well and decay organisms may enter. The roots are trimmed close to the base of the bulb.

Harvesting, like planting, is usually done on contract, the workers receiving so much per bushel pulled, clipped, or hauled, as the case may be. The crew which sorts the bulbs into the various sizes and grades usually works by the hour or day.

Most of the commercial crop is sold in 50-pound open-mesh sacks. These provide good aeration and make attractive packages.

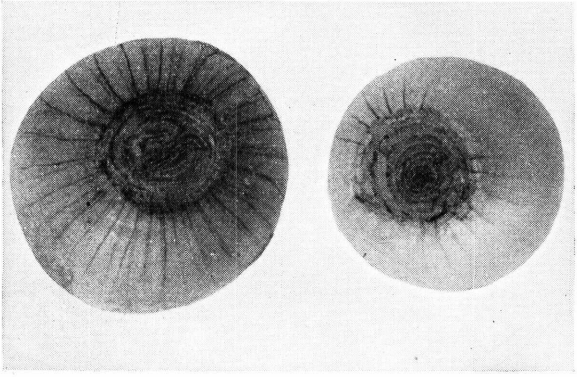

FIGURE 17.—Bulbs clipped too close.

VARIETAL DESCRIPTIONS

The descriptions of most of the onion varieties given here follow closely those in Miscellaneous Publication No. 435, Descriptions of Types of Principal American Varieties of Onions. All the varieties described can be used as transplants.

Yellow Bermuda.—This variety is adapted to the South and Southwest, where it is grown as a winter crop. When it is seeded in mid-September and the seedlings are transplanted to the field in November or December in southern Texas and California, the bulbs usually mature in April and May. It is not adapted to the Northern States when seeded in the field, but when it is seeded in the greenhouse in December or January and the plants set in the field in early spring, it matures in June, July, or later, depending on the locality. Seedlings are grown extensively in the South for shipping North for planting in home and market gardens. The bulbs attain a diameter of 3 to 3½ inches when grown under irrigation in the South and Southwest; they are flat and have very few thin, shiny, pale-yellow skins that are soon broken and lost in handling. The flesh is soft and very mild in flavor.

Crystal Wax.—This variety is adapted to the South and Southwest, where it is grown as a winter crop. When seed is sown in mid-September and transplanted into the fields in November and December in southern Texas and in California the bulbs usually mature in April and May. It is not adapted to the Northern States when grown from seed, but when seeded in the greenhouse in December or January and set in the field in early spring, maturity

is reached in June, July, or later, depending on the locality. Seedlings are grown in the South for shipping and planting in the North. When grown under irrigation in the South and Southwest the majority of the bulbs attain a diameter of 3 to 3½ inches. The bulbs are flat, have very thin, shiny, white, dry skins that are soon broken and lost in handling. The flesh is soft and very mild in flavor. This variety is also grown extensively as a green bunch onion.

Early Grano (Babosa).—This variety, introduced by the New Mexico Agricultural Experiment Station, is adapted to the South and Southwest, where it is grown as a winter crop and to the North, where plants are set in early spring. It is adapted to the same region and matures at the same time as Yellow Bermuda. It is somewhat resistant to damage by thrips, but is very susceptible to injury by the pink root organism. Early Grano bolts much less readily than Yellow Bermuda and Crystal Wax in Texas when planted at the same time and is a heavier yielder. Under irrigation in Texas and in the Southwest the bulbs reach a diameter of 2½ to 3 inches. The bulbs are round to top-shaped and have very few thin to medium-thick pale-yellow skins that are soon broken and lost in handling. The flesh is soft and very mild in flavor.

Red Creole.—Red Creole seems to be fairly well adapted to the southernmost sections of the Southeast and along the coast as far north as Charleston, S. C. At present it is of commercial importance only in southern Louisiana, where it is the chief variety for home and market purposes, as it keeps better in open sheds or barns during the humid summer than any other variety. The outer dry scales are retained fairly well in handling and storage. They are dull buff red on the lower half, with more buff in the veins and on the upper half toward the neck; dry scales become more dull and more buff with age. In the North, bulbs seldom exceed 1 inch in diameter; therefore it is not adapted for use there. In southern Louisiana they reach a diameter of 2 to 2½ inches; they are flat to medium oblate in general shape. The upper half is slightly rounded to slightly tapered; the lower half is flat to slightly rounded. The bulbs have a high dry-matter content and are very pungent and firm in texture.

White Creole.—Same as Red Creole except for being white.

Stockton Yellow Globe.—This variety is the one grown most extensively at present for the intermediate crop in central California. It is a heavy-yielding yellow onion and mild in flavor. The shape is somewhat variable but mostly high flat to globe.

Stockton G36.—This is a highly nonbolting strain of Stockton Yellow Globe, introduced by the California Agricultural Experiment Station. It is especially well adapted for the intermediate crop in the central coastal district of California. The bulbs are yellow, slightly conical, with the top somewhat flattened, and mild in flavor. It matures 10 to 14 days later than Red 21.

Red 21 (California Early Red).—This variety, developed from California Early Red, was introduced by the California Agricultural Experiment Station. It is grown chiefly for the intermediate crop in central California, where it attains very large size, the majority of the bulbs being 3 to 3½ inches in diameter. It is very uniform in size, shape, color, and time of maturity. The scale color is red and the flesh pink. The degree of color varies somewhat with the locality, being much more intense when the onions are grown and matured under low temperatures than when they are grown under high temperatures. It is thick, flat to medium oblate in general shape. The flesh is soft and very mild and sweet in flavor.

Italian Red.—This variety is very productive and is adapted to central California as a late-intermediate crop for immediate local consumption. It is not adapted to the Southern States because of the long daylight required for bulb formation or to the humid or northern regions because of its extreme susceptibility to various bulb rots. When sown in late August or early September and set in the field in November or December it usually matures in late July, the majority of the bulbs reaching a diameter of 2½ to 3 inches. The mature bulbs are torpedo- or long-oval-shaped and have very few medium-thick purplish-red dry skins, which are soon broken and lost in handling. It has the shortest storage life of any of the varieties described in this bulletin. It is highly nonbolting. As most of the bulb forms above the soil level, it may be grown on heavier soil types than other varieties. Italian Red is highly esteemed for salad and garnish purposes because of its attractive color and very mild and sweet flesh.

San Joaquin.—This variety was developed and introduced cooperatively by the California Agricultural Experiment Station and the United States Department of Agriculture. Tests to date show that this variety grows well in Riverside

County and in the San Joaquin Valley of California and in southern Utah. It is a large yellow globe onion maturing at about the same time as Crystal Wax, highly nonbolting, and mild in flavor.

Sweet Spanish.—This variety is best adapted to the western Mountain States and California, where the crop can be grown under irrigation and under fairly dry atmospheric conditions. It also does well as a transplant crop in the North when seed is sown indoors in late December or in January or when southern plants are used. Being a late-maturing variety, it is usually harvested in the North in late August or early September. It is somewhat resistant to thrips. The bulbs are globe-shaped but vary from deep oblate to slightly oval and attain a diameter of 3 to 3½ inches. Because of its succulent, sweet, mild-flavored, almost-white flesh it is greatly esteemed in salads.

White Sweet Spanish.—This variety is similar to Sweet Spanish except that it has an attractive white color. It is grown to some extent as a transplant crop in the North from seed started indoors and from transplants grown in the South.

VARIETAL ADAPTATION

Some varieties of onions are limited in their range of adaptation; others are more widely adapted. A variety may do well, therefore, in one district and be worthless in another. It is essential then for the grower to have a knowledge of the different varieties and to choose those best suited to his particular conditions. New varieties should be tested on a rather limited scale until they have been shown definitely to be adapted to the locality.

The varieties grown in the United States for transplant purposes differ in size, shape, color of bulb, bolting habit, pungency, keeping quality, time of maturity, and tolerance to diseases, insects, sunscald, and high and low temperatures. No one variety is suited to all conditions and for all purposes. The adaptation of varieties to certain regions is determined largely by the conditions which affect bulbing, chiefly temperature and length of day. The minimum length of day necessary to cause bulbing varies with the different varieties but is affected by temperature. At favorable lengths of day, temperatures below 60° F. may inhibit bulb formation, whereas temperatures above 70° accelerate it. The attainment of maturity requires a longer day than does the start of bulb formation. In other words, a certain day length may cause a variety to start bulbing, but a still longer day is required for the bulb to develop and mature properly. The size or age of the plant at the time the minimum temperature and length of daylight are reached is also a factor, because late planting delays somewhat the date of maturity. If seed and transplants are planted at the same time, the latter will mature first. Thick plantings also mature more quickly than thin plantings. Any increase in temperature or length of day above the minimum will hasten maturity. Because of lower temperatures, plants grown at high altitudes mature later than those at lower altitudes.

Trials conducted at Winter Haven, Tex., showed that only those varieties that mature their bulbs by April 15 to May 15 (Crystal Wax, Yellow Bermuda, Early Grano, White Creole, and Red Creole) are able to make acceptable commercial crops. The late-maturing varieties of onions usually do poorly in the South. They may start to form bulbs, but the necks remain thick and never ripen properly. The minimum length of day for initiation of bulbing of certain storage types is reached about April 20 at Winter Haven; for other varieties the minimum length for such initiation is never reached. By April 20, however, temperatures are high and pink root and thrips abundant, so that continued increase in size is impossible. The early-maturing

varieties escape the detrimental effects of high temperature and the most severe damage from thrips and pink root.

In the North it is almost impossible to obtain good yields of the extra-early varieties, such as Bermuda and Early Grano, by sowing seed directly in the field, because seeding is usually done at a date when the length of day has already passed the minimum for the bulbing of these varieties. After a few weeks, temperatures have also passed the minimum; consequently the plants develop only a few leaves and small bulbs. To obtain large bulbs of the extra-early varieties in the North, it is necessary to set well-developed transplants in the field as early in the spring as possible in order to get a large plant before bulbing starts.

The Red Creole variety does not seem to be able to form bulbs of commercial size in the North even when large seedlings are transplanted to the field in early spring. A striking example of poor adaptation is shown in figure 18. Rows that appear vacant in the center were planted with Red Creole transplants on March 31 in peat soil in the Delta district of central California. At that time the minimum length-of-day and temperature requirements for bulbing had been reached; consequently no new foliage was developed. Bulbing started very soon after transplanting, and the plants matured when the bulbs were about one-half inch in diameter. Rows on either side of the Red Creole were of the storage varieties.

FIGURE 18.—A striking example of poor varietal adaptation in the Delta district of California. Rows in center which appear vacant were set with Red Creole plants on March 31. At that time both temperature and length of day exceeded the minimum necessary for bulbing. No new foliage developed after transplanting, and small bulbs about one-half inch in diameter were formed.

FIGURE 19.—A field of Crystal Wax onions in Texas with a very high percentage of bolters. This field was practically a total loss to the grower and is an example of what is likely to happen when seed of poor quality is planted.

In central California a considerable acreage of the so-called intermediate crop of onions is grown. Seed is usually sown in field beds in late August or early September, and the seedlings are transplanted in late November and December. During winter and early spring the plants usually make a large vegetative development, but bulbing does not begin until the minimum requirements of temperature and length of day are reached for the varieties in question. If the early varieties of the South or the late storage types of the North are used, they make a good vegetative growth, but in the spring many of the plants form seed stems instead of bulbs. Therefore, varieties such as Stockton Yellow Globe, Red 21, and Italian Red, which do not have a tendency to bolt readily, must be used.

Not only is it important to use varieties that are adapted to the district, but for best results it is essential that good strains of the respective varieties be obtained. It is not uncommon for a grower to lose practically his entire crop when seed of poor quality is planted (fig. 19).

STORAGE

The varieties used for the transplant crop, with the exception of Red Creole, do not keep well in storage; growers, therefore, usually dispose of the crop shortly after harvest. For home consumption, however, it is often necessary to store bulbs for several weeks. They should be well cured so that the neck tissue is thoroughly dry. The bulbs should then be placed in well-aerated containers such as crates or open-mesh bags and stored in dry rooms that have a good circulation of air. The storage life of most varieties can be prolonged considerably by placing them in cold storage at 32° F. According to

storage tests of the United States Department of Agriculture and a number of cooperating States, Italian Red is a very poor storage onion; California Early Red, Crystal Wax, Yellow Bermuda, and Early Grano poor; White Sweet Spanish, Prizetaker, and Sweet Spanish fair; and Red Creole and White Creole very good. For further information on these tests, see Circular No. 618, Storage Quality of the Principal American Varieties of Onions. (Out of print; may be consulted in libraries.)

DISEASES, ESPECIALLY PINK ROOT

Pink root, caused by the soil-inhabiting fungus *Phoma terrestris* Hansen, is probably the most prevalent and most destructive disease found throughout the South and West where the transplant crop is grown commercially.

Pink root symptoms are rather easy to identify. As the name indicates, the roots are the organs chiefly attacked, and these shrivel and die and take on a distinctly pinkish color. Symptoms may appear on the roots of the very young seedlings, and as the plant develops and sends out new roots they in turn become diseased and functionless. As a rule, the plants are not killed by the disease, but when the root system is severely injured bulbs may not form or may remain small and yields are greatly reduced. The tips of the leaves often wither and die, making them susceptible to various fungus leaf blights.

Injury increases on succeeding crops of onions, and damage becomes more and more pronounced. During the cool winter months damage is usually not severe, but as the temperature becomes warmer in the spring the organism becomes increasingly active.

The control of pink root is a very difficult problem once the soil becomes infested. The only practical control is to use a long rotation. Other crops should be planted for a period of 3 years or longer.

If possible, the seedbed should be located on soil free from pink root infestation, preferably on land that has not grown onions previously. This is a very important consideration, as seedlings with diseased roots will inoculate the soil wherever they are planted.

So far as is known, none of the present onion varieties are immune to pink root. Certain varieties, however, are much more susceptible than others and should not be planted on infested soil. Early Grano is especially susceptible. Yellow Bermuda, on the other hand, is somewhat resistant but will suffer severely on badly infested soil.

A number of other diseases of onions are discussed in Farmers' Bulletin No. 1060, Onion Diseases and Their Control.

INSECTS, ESPECIALLY THRIPS

Thrips are the most destructive insects on the transplant onion crop. The amount of damage varies from season to season, but some injury occurs practically every year in many areas. In the South thrips live on the onion crop throughout the winter. In the North onion thrips pass the winter on bulbs in storage, on onion plants which survive in the field, and on hardy plants.

The female lays her small whitish eggs in the tissue of the onion leaf. Under high temperature conditions the eggs hatch in about

5 days; under cool conditions it takes somewhat longer. The small white larvae feed on the center leaves, where the tissue is tender and they are well protected. In about 5 days the larvae attain full size, leave the plants, and drop to the soil, where pupation occurs. The pupal stage lasts about 4 days under warm and somewhat longer under cool temperature conditions. Thus a complete generation extends over about 2 weeks, depending upon the temperature. If the growing season is warm more generations will occur than if the season is cool.

Environmental conditions during certain seasons may hold thrips damage to a minimum. Cool weather reduces the number of generations; hard, driving rains wash the thrips from the plants and destroy many of them; and predatory insects also aid in reducing infestations.

No entirely satisfactory commercial control of onion thrips has yet been developed. While these insects are readily killed by contact insecticides such as nicotine, it is necessary that the spray come in direct contact with the pest; this is not readily accomplished by field spraying because many of the thrips are well protected by the onion leaves. Furthermore, these sprays do not affect the eggs, which are imbedded in the onion leaf, and the pupae, which are found in the soil around the onion plants. In recent experiments on the control of onion thrips, contact insecticides have proved to be less effective than a poisoned spray containing a sweetening agent. The most effective spray of this character contains 2 pounds of tartar emetic and 4 pounds of granulated sugar mixed with 100 gallons of water, or 2 teaspoonfuls of tartar emetic, 2½ tablespoonfuls of sugar, and 1 gallon of water. In order that the spray be effective, it is necessary to cover the foliage with a fine mist, using about 125 gallons of the mixture to the acre. The material should be applied before the thrips become abundant and repeated approximately at weekly intervals throughout the growing period of the crop.

Tartar emetic is a stomach poison to man and warm-blooded animals and therefore should be handled with care. For this reason its use on onions grown for the green market is not to be recommended. Tartar emetic when ingested even in very small quantities causes serious gastric disturbances. The undiluted chemical must be handled carefully. Use care in storage of either the undiluted chemical or the spray. Vessels used in mixing should be thoroughly cleaned before being used for any other purpose. All surplus spray should be disposed of in such a way that animals cannot come in contact with it.

For the control of onion thrips on young green bunch or table onions a nicotine solution prepared as follows may be used: Nicotine sulfate, 1 quart; cane molasses, 2 quarts (3 quarts of corn sirup or 6 quarts of beet molasses may be substituted for the cane molasses as the sweetening agent); and water, 100 gallons.

Nicotine sulfate is also poisonous, but it is volatile and therefore should not leave a harmful residue on the plant 3 or 4 days after treatment. Undiluted, it is highly poisonous and should be handled according to directions. Vessels used in mixing the spray should be thoroughly cleaned before being used for any other purpose. Use care in storing this compound.

GRADING

Most of the onions produced in the large commercial areas are graded before being shipped. The grade specifications vary somewhat for Red Creole, Bermuda, and northern-grown onions; so they are not given here. The United States standards for these types may be obtained by writing the Office of Distribution, War Food Administration, Washington 25, D. C.

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